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The Macrobenthic Algae of Beymelek Lagoon (Antalya-Turkey)

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Abstract

This study was conducted with species the macrobenthic algae which have been seasonally collected from 5 stations located on Beymelek Lagoon Lake and 6 other lying along the coastal areas. Besides, varying salinity rates and the temperature values of the lake depending upon its depth have been measured during the study. Seven species of Chlorophyceae (*Gayralia oxysperma* (Kützing) K.L. Vinogradova ex Scagel *et al., Enteromorpha linza* (L.) J.G. Agardh*, E. prolifera* (O.F. Müll.) J.G. Ag*., E. intestinalis* Link*, Ulva rigida* C. Agardh*, Chaetomorpha crassa* (C. Ag.) Kütz*., Cladophora coelothrix* (J. Ag.) Harvey) and 2 species of Rhodophyceae (*Porphyra leucosticta* Thuret in Le Jolis*, Polysiphonia urceolata* (Lightfoot)) Greville have been found to constitute the macrobenthic algae existence on Beymelek Lagoon Lake. The lake is of mesohalin characteristics in winter-spring seasons and of polihalin characteristics in summer-autumn seasons. The above-mentioned macrobenthic algae except species *C. crassa* are all new brand floristic records for the region. This study also reveals that the algae *Gayralia oxysperma,* of which the seasonally changing biomass values were recorded at 5.0 - 55.3 g/m^2, can be exploited economically in the region.

Key words: Beymelek Lagoon, Macrobenthic, Algae

Introduction

Lagoons are shallow coastal bodies of salty or brackish water separated from the sea/ocean by a series of barrier islands, which lie parallel to the shoreline (Beer, 1983; Thurman, 1983). Although aquatic ecosystems are thought to possess similar characteristics with respect to their productivity and the living forms they surround; primary and secondary productivity are higher in brackish lagoons and in the areas where algae are densely found (Nybakken, 1988; Mann, 1991). In addition to their basic functions within the ecosystems, the fact that macrobenthic algae are used in the processes of food, food additive, and fertilizer material production as well as water treatment and that some products used in medical and pharmaceutical fields such as agar agar, carrageen and alginic acid are extracted from them are widely known (South, 1963; Levring *et al*., 1969; Delepine *et al*., 1987). Beymelek lagoon has an area of approximately 350 ha and is connected to the Mediterranean Sea by a narrow strait. Lake Kaynak, which feeds the lagoon and takes up an area of some 6 ha, is connected to the lagoon with a narrow channel (Anonymous, 1984). Any other study on algae has never been done in this region except for those performed in 1984 and 1998. While the former suggested that a mass of threadlike algae had been found in eastern and northern parts of the lagoon, the latter stated that *C. crassa* was a brand new floristic record not only for the region and but also for Turkey (Anonymous, 1984; Yağcı (Apaydın) and Turna, 2002).

Materials and Methods

The Study Area and the Sampling Stations

This study was conducted seasonally. The samples were collected in August (summer), and October (autumn) in 1998, in February (winter), April and May in 1999. This study was realized on 5 stations located on Beymelek Lagoon Lake to the west of Antalya as well as Lake Kaynak which has an area of some 6 ha and connection with that lagoon, and 6 other stations along the coastal areas (Figure 1).

Stations located on the lake; Station I: The mouth part, which connects the lake to the sea. Station II: Spot, which approximately has a 500 m distance from the mouth part. Station III: A spot to the north-east of the lake, which is approximately 600 m of the coast. Station IV: A spot to the centre and to the south of the lake, which is approximately 700 m of the coast. Station V: The area stretching from the centre of the lake to the channel, which has a connection with the lagoon.

Coastal Stations; Station VI: The coastline to the south of the lagoon, which stretches from the mouth part of the lake to Lake Kaynak. Station VII: The coastline of Lake Kaynak. Station VIII: The coastline to the west of the lagoon. Station IX: The coastline to the north-east of the lagoon, which is approximately 400 m long. Station X: The coastline to the north of the lagoon, which stretches from the mouth part of the lake to the Station IX. Station XI: Coastline of the island which has an area of approximately 500 m^2 located to the north of the lagoon.

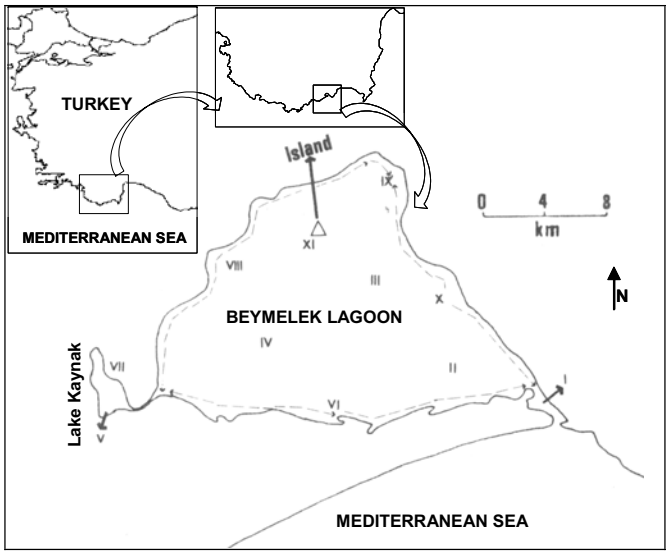

Figure 1. The study area and the sampling stations
I–V: Stations Located on the Lake VI–XI: Coastal Stations

Water Analyses

Water analyses are based on the samples taken from the surface at the coastal stations (VI-XI), and those taken from the surface and the bottom at the stations located on the lake (I-V). Digital instruments determined water temperature, quantity of dissolved oxygen, pH, and the salinity rates, by measuring the density by refractometer; the turbidity by secchi disc, and the depth by fathometer.

Collection and Evaluation of the Samples

While the samples on the coastal stations were collected by hand (VI-XI), those at the offshore stations were collected by a sediment grab (I-V). All of the collected samples were deposited in a formaldehyde solution of 4 %.

Articles and basic sources written by the prominent figures of this field (Oltmanns, 1922; Fritsch, 1945; Fritsch, 1965; Ünal, 1973; Bell and Woodcock, 1983) in addition to the systematic studies conducted not only in our country (Güner and Aysel, 1977; Güner and Aysel, 1978; Aysel, 1979; Zeybek *et al*., 1983; Dural, 1989; Dural, 1990) but also abroad (Migula, 1909; Haas and Knorr, 1966; Nizamuddin and Begum, 1973; Kapraun, 1977; Womersley, 1984; Fischer *et al*., 1987; Burrows, 1991) were much referred during the specification of the species. A frame of 25 x 25 cm was placed on the surface of water at Lake Kaynak (Station V.), where *G. oxysperma* had formed a dense population and the plants inside were picked up by hand. The samples were collected on a three time basis, separated from other substances (other algae species, Spermatophyta etc.), blotted, and finally their fresh weight were determined. The results were noted on a g/m^2 basis.

Results

Quality of Water

Varying values regarding the quality of water at the study stations were as follows: water temperature, 14.10ºC (winter) - 35.10ºC (summer); salinity, 8.50‰ (spring-autumn) - 39.25‰ (summer); pH, 7.46 (spring) - 8.90 (autumn); density, 1.003 g/cm^3 (spring) - 1.029 g/cm^3 (summer); depth, 1.75m (spring-autumn) - 3.50 m (spring). Varying water quality values according to the seasons and the stations are given in Table 1.

Macrobenthic Algae

Phylum : Chlorophyta (Green Algae)
Class : Ulvophyceae
Order : Ulvales
Family : Gayraliaceae
Genus : *Gayralia*
***Gayralia oxysperma* var.** *oxysperma* (Kützing) Vinogradova ex Scagel *et al*., 1989 (Figure 2).

Syn: *Monostroma orbiculatum* Thuret; *Monostroma oxyspermum f. orbiculatum* (Thuret); *Ulva oxysperma f. wittrockii* (Bornet) Bliding; *Ulvaria oxysperma f. wittrockii* (Bornet) Bliding; *Ulva oxysperma* Kützing, 1843; *Ulva oxycocca* Kützing, 1845; *Monostroma oxycoccum* Thuret, 1854; *Monostroma latissimum* Wittrock, 1866; *Monostroma crepidinum* Farlow, 1881; *Monostroma oxyspermum*

Table 1. Water Quality Values of Beymelek Lagoon (1998-1999)

	Stations	Seasons			
		Spring	Summer	Autumn	Winter
Water Temperature (ºC)	I	21.45	30.30	22.15	15.45
	II	22.65	26.85	21.40	15.95
	III	21.70	30.65	19.45	16.65
	IV	22.15	31.65	23.60	16.60
	V	18.35	23.10	18.25	16.25
	VI	22.0	35.10	18.80	15.30
	VII	18.30	24.00	20.00	16.00
	VIII	22.60	28.00	28.00	16.50
	IX	22.40	29.10	27.30	15.50
	X	20.20	32.40	16.70	14.10
	XI	21.20	30.80	18.90	16.90
	Average	21.18	29.26	21.32	15.92
Salinity (‰)	I	15.65	39.25	26.75	17.00
	II	14.35	31.75	26.50	19.50
	III	14.95	35.35	27.50	17.50
	IV	16.10	36.80	24.75	19.50
	V	9.80	11.75	9.20	10.40
	VI	15.70	36.20	22.00	18.00
	VII	9.60	10.70	8.50	10.00
	VIII	14.10	27.40	26.40	14.00
	IX	8.70	28.10	25.00	12.10
	X	8.50	31.00	17.20	13.10
	XI	15.00	29.20	27.60	15.00
	Average	12.95	28.86	21.94	15.10
pH	I	8.37	8.12	8.20	8.41
	II	8.32	8.06	8.14	8.31
	III	8.52	7.98	8.41	8.33
	IV	7.98	8.02	8.25	8.37
	V	7.85	7.62	7.79	7.56
	VI	8.78	8.12	8.27	8.54
	VII	7.46	7.50	7.52	7.58
	VIII	8.05	7.95	8.90	8.45
	IX	8.45	7.96	7.90	8.40
	X	8.25	8.10	7.75	8.65
	XI	8.44	8.11	8.45	8.36
	Average	8.22	7.95	8.14	8.26
Density (g/cm^3)	I	1.011	1.029	1.020	1.012
	II	1.010	1.023	1.020	1.013
	III	1.011	1.025	1.014	1.010
	IV	1.012	1.027	1.019	1.012
	V	1.009	1.008	1.008	1.008
	VI	1.012	1.026	1.016	1.010
	VII	1.006	1.011	1.008	1.008
	VIII	1.011	1.018	1.015	1.009
	IX	1.003	1.009	1.020	1.007
	X	1.009	1.020	1.013	1.008
	XI	1.011	1.022	1.010	1.010
	Average	1.009	1.019	1.014	1.009
Depth (m)	I	1.75	2.00	1.75	1.80
	II	2.25	2.30	1.90	1.85
	III	2.50	2.40	2.30	2.30
	IV	2.75	2.35	2.20	3.00
	V	3.50	2.20	2.50	3.00

(Kützing) Doty, 1947; *Monostroma tubiforme* Iwamoto, 1960; *Ulvaria oxysperma* (Kützing) Bliding, 1969.

Ref. Giaccone,1978; Gallardo *et al*., 1985; Zeybek *et al*., 1986; Dural, 1986; Dural, 1988; Ganesan, 1990; Silva *et al*., 1996; Furnari *et al*., 1999; Benhissoune *et al*., 2001; Haroun *et al*., 2002; South and Skelton, 2003.

A light green algae with oval-like thallus is 3.5 - 4.5 cm long and 2.5-3.5 cm wide. When examined by hand, this algae feels somewhat slippery. Its apical region is of rough characteristics. Cross-sectional parts of the thallus showed that ellipsoid and kidney shaped surface (uppermost) cells with one pyrenoid (rarely two) of this algae, which had a single row cell content, had a size (thickness) of 7.5-10 × 10-12.5 µm on end parts and 7.5-10 ×10 µm on middle parts. They also formed twosome or foursome groups (rarely threesome) on middle parts, and twosome groups (rarely one, threesome) in apical region (Figure 3). This species of algae, the samples of which were seasonally collected exclusively from the surface of Lake Kaynak (Station V), was proved to have been densely found in summer and autumn periods, yet sparsely in winter period. Moreover, these algae together with some of the green algae (*E. prolifera, E. intestinalis, C. coelothrix, C. crassa*) were found out to be the main factors for the water surface looks green.

Distribution : Adriatic, Italy, Spain, Canary Islands, Venezuela, Kenya, Morocco, Burma, Fiji, Turkey.

Family : Ulvaceae
Genus : *Ulva*
U. rigida C. Agardh (Figure 4).

Syn: *Phycoseris rigida* (C. Agardh) Kützing, 1843; *Phycoseris ulva* Sonder, 1845; *Phycoseris gigantea* var. *perforata Kützing,* 1849; *Ulva australis* Areshoug, 1854; *Ulva lactuca* var. *rigida* (C. Agardh) Le Jolis, 1863; *Letterstedtia petiolata J.* Agardh, 1883; *Ulva petiolata* (J. Agardh) Womersley, 1956; *Ulva spathulata* Papenfuss, 1960

Ref. Güner and Aysel, 1977; Womersley, 1984; Güner *et al*., 1985; Zeybek *et al*., 1986; Ganesan, 1990; Burrows, 1991; Gallardo *et al*.,1993; Aysel and Erduğan, 1995; Silva *et al*., 1996; Turna, 1997; Kurt *et al*., 2000; Benhissoune *et al*., 2001; Haroun *et al*., 2002

U. rigida, which is dark green algae, have an unbranched thallus and oval, leaf-like shape. Hole-like structures on the thallus, soft and round appearance of the edges along with rough form of the end parts are all typical characteristics. This species is 5-8 cm in wide, whereas its height is almost 0.3-1.5 in cm. Furthermore, the facts that membrane thickness

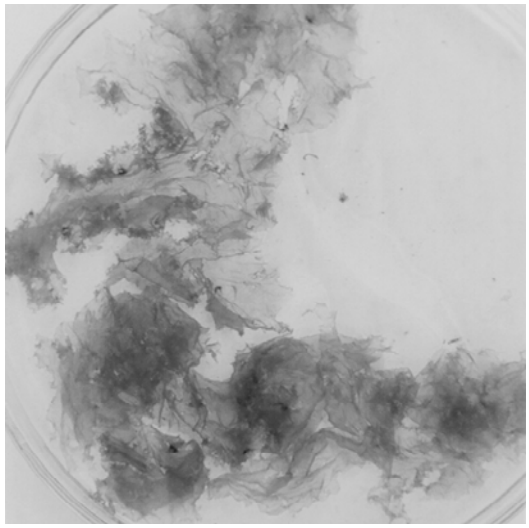

Figure 2. *G. oxysperma.*

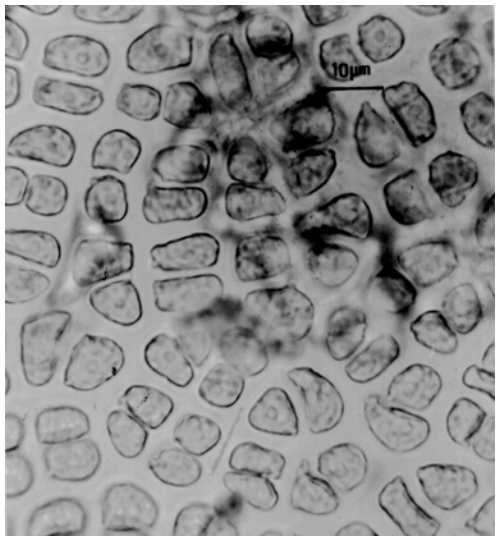

Figure 3. Cells surface apical region of *G. oxysperma*. Scale= 10 µm.

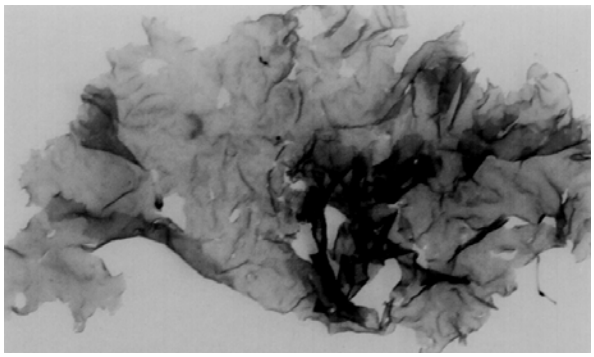

Figure 4. *U. rigida.*

of the cross-sectional parts might vary between 100 µm and 200 µm, that ellipsoid shaped cells were lined up in two rows, and square and rectangular surface cells in the apical region had a size of 10-20 x 12.5-25 µm were also determined. This species, which was sampled only during spring and winter seasons, was found to be more densely populated in spring than in winter. *U. rigida*, which is sparsely populated along the coasts of Lake Kaynak (Station VII), densely at the Station IX, was also found to have dispersed in an epilitic habitat extending from mediolittoral zone up to 1.6-0.7 m depth. In addition, free-floating samples of this algae were also observed on the water surface.

Distribution : Adriatic, Balearic Islands, Black Sea, Britain, Italy, France, Spain, Canary Islands, Caribbean, Venezuela, Madagascar, Morocco, Aldabra Islands, Victoria, South Australia, India, South Arabian Coast, Turkey.

Order : Cladophorales
Family : Cladophoraceae
Genus : Cladophora
Cladophora coelothrix (J. Ag.) Harvey (Figure 5).

Syn : *Conferva repens* J. Agardh, 1842; *Aegagropila coelothrix* (Kützing), 1845; *A. repens* (J.G.Agardh) Kützing, 1845; *Conferva spongiosa* Zanardini, 1847; *Cladophora repens* (J. Ag.) Harvey), 1849; *C. bryopsoides* Zanardini ex Frauenfeld, 1855; *C. repens* f. *tenuis* Bornet ex Hamel, 1929.

Ref. Nizamuddin and Begum, 1973; Womersley, 1984; Güner *et al*., 1985; Ganesan, 1990; Burrows, 1991; Gallardo *et al*., 1993; Aysel and Erduğan, 1995; N'Yeurt *et al*., 1996; Silva *et al*., 1996; Turna, 1997

This threadlike algae species, of which thallus is light green - yellowish green, is 3-5 cm in long. Following a microscopic examination, it was understood that the thallus has branched unilaterally and the cells of the main axis has a size of 70-600 µm, while those of the branches are 45-475 µm. It was also revealed that a number of diatoms have developed on the thallus and that the cells contained many pyrenoids. *C. coelothrix*, which was sampled on Lake Kaynak (Station V-VII) in spring and autumn, and on the coastal parts (Station XI.) in summer, was found to have been dispersed in an epilitic habitat extending from mediolittoral zone up to 0.3-0.4 m depth. Furthermore, *C. coelothrix,* which is the main factor for the coastal parts looks green as a result of its forming felt like groups in substrates, was determined to be in masses on the water surface together with the other algae.

Distribution: Adriatic, Balearic Islands, Black Sea, Britain, Italy, France, Greece, Spain, Canary Islands, Venezuela, South Africa, Christmas Islands, Pakistan, India, Pakistan, South Australia, Fiji, Turkey.

Genus: *Chaetomorpha*
Chaetomorpha crassa (C. Ag.) Kütz. (Figure 6).

Syn: *Conferva crassa* C. Agardh, *Conferva torulosa* Zanardini 1843, *Chaetomorpha torulosa* Kützing 1845

Ref. Nizamuddin and Begum, 1973; Ganesan, 1990; Gallardo *et al*., 1993; N'Yeurt *et al*., 1996; Silva *et al*., 1996; (Apaydın) Yağcı and Turna, 2002

C. crassa a dark green – yellowish green algae species is 13-18 cm in long and its thallus looks like unbranched filaments. When examined closely, its cylindrical shaped structure can also be easily recognized. During microscopic examination, thallus was proved to have been formed by square and rectangular cells lined up over and (Station V) and its shores (Station VII). These cells demonstrated a webby chloroplast form and included a number of pyrenoids. The cells of C. *crassa* are 240-440 µm wide, 430-560 µm long, and their membrane thickness is 50-85 µm. This species, whose samples were seasonally studied on Lake Kaynak was found to have formed groups together with the species other (*Cladophora* and *E. intestinalis, E. prolifera*) densely populated in summer and autumn.

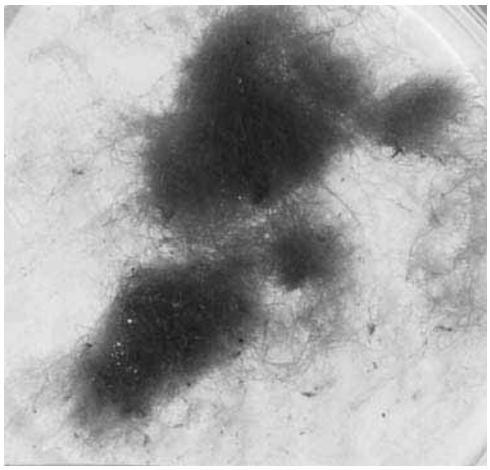

Figure 5. *Cladophora coelothrix.*

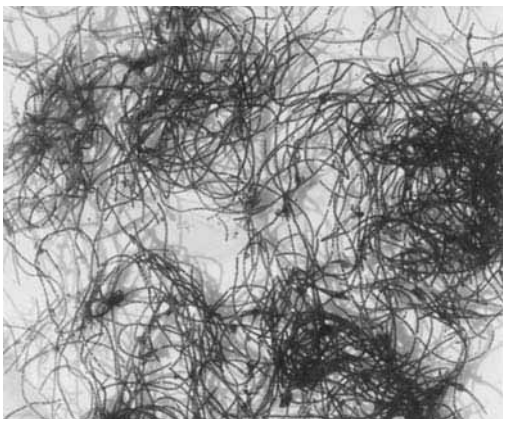

Figure 6. *Chaetomorpha crassa.*

Distribution: Adriatic, Balearic Islands, Italy, Spain, Venezuela, Kenya, Madagascar, South Africa, India, Pakistan, India, Kenya, Fiji, Turkey

Class : Chlorophyceae
Order : Ulotrichales
Family : Ulvaceae
Genus : Enteromorpha

Identification Keys to The Species of *Enteromorpha* Link

1 - Thallus, which has a leaf shape and curly edges ……..*E. linza*
- Thallus, which has a tube-like or intestinal shape 2

2 - Thallus is greenish yellow-yellow …...*E. prolifera*
- Thallus is dirty green- dark green.....*E. intestinalis*

E. linza (L.) J.G. Agardh (Figure 7).

Syn: *Ulva linza* L.; *Enteromorpha linza* var. *crispata* (Bertoloni) Doty; *E. linz*a var. *flexicaulis* Doty; *E. linza* var. *lanceolata* (L.) Doty; *E. linz*a var. *oblanceolata* Doty.

Ref. Fraunfeld, 1855; Feldmann, 1937; Zeybek, *et al*., 1983; Güner *et al*., 1985; Dural, 1989; Turna, 1997.

Dark green, leaf-like, unbranched and curly-edged; this species was almost 0.3-1 cm wide and 7-30 cm long. Cross-sectional parts of the thallus were proved to have cells in single row. Also, cell wall thickness is 80 µm. On the other hand, ellipsoid and kidney shaped surface (uppermost) cells which were 12.5 × 15-17 µm have formed irregular rows. The algae species *E. linza* lives in epilitic habitat, an area extending from the mediolittoral zone up to the 40 cm depth of the coastal parts of the island (Station XI). Members of this species have reproduced on water surface on the north-east parts of the Lagoon, where they could easily find shelters against the waves (Station IX). This species, the samples of which were seasonally studied, was found to be denser in spring period than in the others.

Distribution: Adriatic, Greece, North Atlantic, Black Sea, Turkey.

E. prolifera (O.F. Müll.) J. G. Agardh (Figure 8).

Syn: *Ulva prolifera* O.F. Müller *Enteromorpha compressa* var. *prolifera* (O.F. Müller) Greville

Ref. Giaccone, 1969; Dural, 1990.

Tube-like or intestinal shaped, greenish yellow – yellow thallus is 8.5-26 cm long and 2.5-3.5 cm wide. In the light of examined cross-sectional parts, cell walls were determined to have a thickness of 30 µm and the cells present to be lined up in a single row (Figure 9). Besides, the fact that the surface cells (mostly oval-shaped) with one pyrenoid (rarely two) forming one (rarely twosome) group had a size of 10 x12 µm, was also determined (Figure 10).

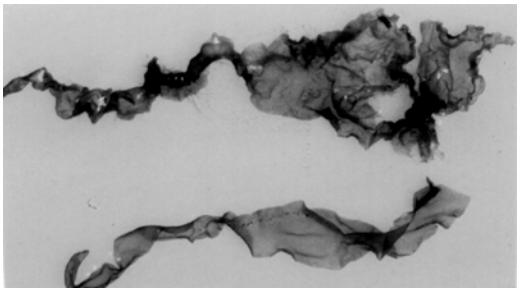

Figure 7. *Enteromorpha linza.*

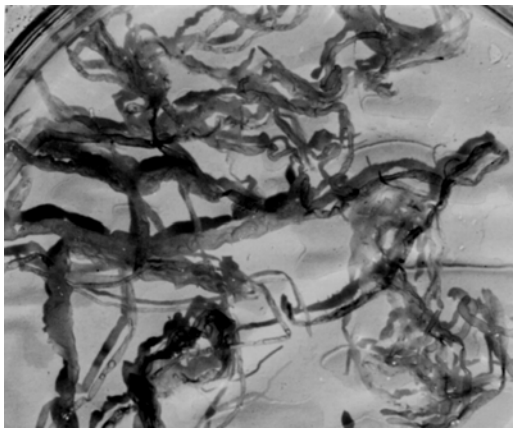

Figure 8. *Enteromorpha prolifera.*

Figure 9. Cross-sectional of *Enteromorpha prolifera* Scale 10 µm.

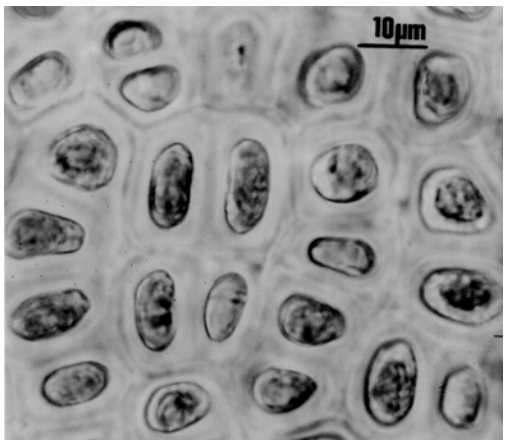

Figure 10. Cells surface of *Enteromorpha prolifera* Scale 10 µm.

As indicated by the data acquired, the species *E. prolifera,* sampled exclusively on Lake Kaynak and its shores (Station V and VII), is not found in spring period, whereas its population increases significantly in summer. Furthermore, *E. prolifera* was proved to be the main environmental factor which causes the water surface looks frothy as a result of peculiar color and structure of the thallus.

Distribution : Adriatic, Turkey.

***E. intestinalis* (L.) Link (**Figure 11).

Syn: *Ulva intestinalis* L.

Ref. Schiffner and Vatova, 1937; Basson *et al*., 1976; Dural, 1990; Turna, 1997.

Dark green - dirty green thallus, which is tube-like or intestinal shaped, is approximately 9-39.5 cm long and 1-3 mm wide. *E. intestinalis* has single row cell content and surface cells with one (rarely two) pyrenoid. On the other hand, these cells having a size of 10- 12.5 x 15-17.5 µm are subjected to the structural changes (rectangular and square in apical region (Figure 12), and oval with a size of 7.5-10 x 12.5-17.5 µm in middle parts). This species, whose samples were seasonally studied exclusively on Lake Kaynak (Station V) and its shores (Station VII), was found to have been densely populated in the region during winter-autumn seasons and reproduced on the water surface as well as the rocks up to 2.5 m depth.

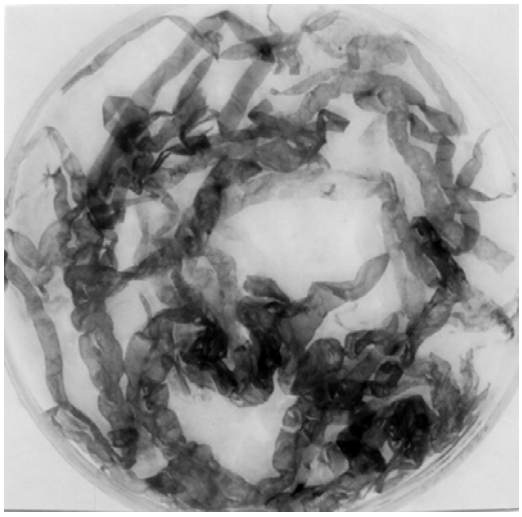

Figure 11. *Enteromorpha intestinalis.*

Distribution: North Adriatic, Lebanon, Turkey

Phylum : Rhodophyta
Class : Rhodophyceae (Red Algae)
Order : Bangiales
Family : Bangiaceae
Genus : *Porphyra*
Porphyra leucosticta Thuret in Le Jolis (Figure 13).

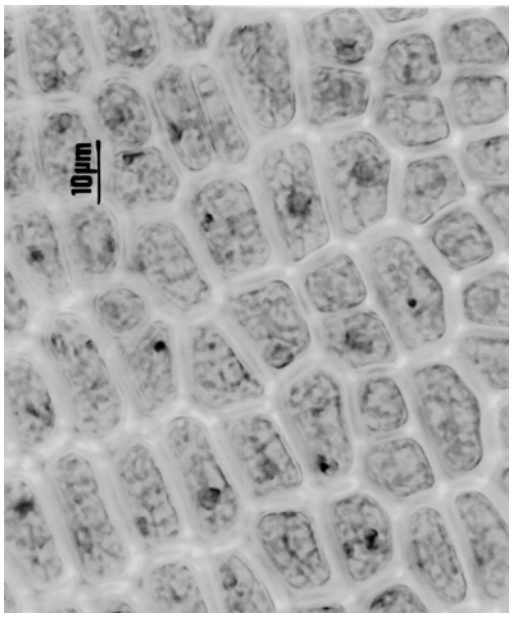

Figure 12. Cells surface apical region of *Enteromorpha intestinalis*. Scale 10 µm.

Syn : *Porphyra coriacea* Zanardini; *Ulva atropurpurea* Olivi; *Porphyra vermicellifera Kützing, 1843; Porphyra lacinata* var. *elongata* Areshoug, 1862*; Phyllona coriacea* (Zanardini) Kuntze, 1891*; Phyllona vermicellifera* (Kützing) Kuntze, 1891; *Phyllona atropurpurea* (Olivi) Kuntze, 1898; *Porphyra elongata* (Areschoug) Kylin, 1907.

Ref. Güven and Öztığ, 1971; Giaccone, 1978; Aysel *et al*., 1986; Zeybek *et al*., 1986; Aysel, 1997; Furnari *et al*., 1999.

4.5-6.5 cm wide and 22.5 µm thickness, flat shaped thallus is dark red or pinky-rose. When examined by hand, this algae species feels slippery. It was also revealed that cross-sectional parts of the *Porphyra* had a single row cell (oval-shaped) content and that ellipsoid and kidney shaped surface (uppermost) cells formed twosome (rarely one, foursome) groups.

Figure 13. *Porphyra leucostica.*

Surface cells in the apical region of the thallus have a dimension of 5-10 ×12.5 µm and these cells contain a central transparent pinky-rose pyrenoid which has a dimension of 3-4 ×5-8 µm. An epifitic (on phanerogams) and epilithic (on the rocks), *P. leucosticta* was sampled on the coastal parts of Lake Kaynak (Station VII) from the mediolittoral zone up to 1.5 m depth and was found to be less densely populated at the station mentioned above when compared to the population of other algae

Distribution: Adriatic, Italy, Egypt, Turkey.

Polysiphonia urceolata (Lightfoot ex Dillwyn) Greville (Figure 14).

Ref. Kapraun, 1977; Zeybek *et al*., 1986; Aysel and Erduğan, 1995

Thread-like and simpoidal, the algae species *P. urceolata* is 3-7 cm long and reddish brown in color. Axis thickness of the thallus was measured 100 µm and the number pericentral cells was 4 in crushed preparations. The central cells of *P. urceolata* have a dimension of 57.5-75 x 2.5-12.5 µm and the pericentral ones 62.5-120 x 5-12.5 µm (Figure 15). Besides, the fact that 25 µm thick, single-cell transparent rhizoids, which grow parallel to the substratumsurface of the thallus, might have a length of 500 µm, was also observed (Figure 16). The alga species *P. urceolata,* which was sampled seasonally except for winter on Lake Kaynak (Station VI, IX, XI), was proved to live in epilitic habitat, an area extending from the mediolittoral zone up to the 0.4 m depth, and to have reproduced on water surface on the north-east parts of the Lagoon, where they could easily find shelters against the waves (Station IX). *P. urceolata* causes the stones and the rocks at that station to look reddish. These red algae are densely found in spring.

Distribution: Pakistan, Turkey

Maximum Biomass of *Gayralia oxysperma*

G. oxysperma was proved to have been densely populated on the one-third (1/3) part of Lake Kaynak (Station V) during the study. Furthermore, the facts that this species neither reproduce, nor exist on the northern parts of the lake and that its density had varied 5.0 g/m^2 (winter) - 55.3 g/m^2 (summer) depending upon the seasons were also determined (Table 2).

Table 2. Seasonally Changing Maximum Biomass Values of *G. oxysperma*

Seasons	Weight (g/m^2)
Spring	20.9
Summer	55.3
Autumn	42.4
Winter	5.0

Figure 14. *P. urceolata.*

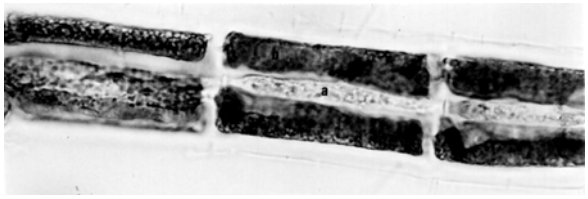

Figure 15. Cells central (a) and pericentral (b) of *P. urceolata.*

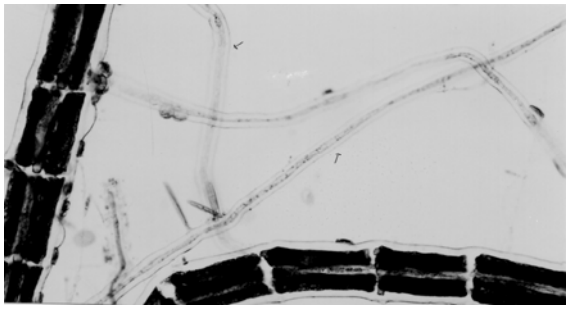

Figure 16. Rhizoids of *P. urceolata.*

Discussion

The macrobenthic algae flora of Beymelek Lagoon is as follows: Those belonging to Chlorophyceae such as *G. oxysperma, E. linza, E. prolifera, E. intestinalis, U. rigida, C. crassa, C. coelothrix,* and those belonging to Rhodophyceae such as *P. leucosticta,, P. urceolata*. The above-mentioned macrobenthic algae species except for *C.crassa* are all brand new floristic records for the region. Brown algae have not been found on Beymelek Lagoon. It is stated that three genera (*Pleurocladia* A. Braun, *Heribaudiella* Gomont and *Bodanella* Zimmermann) of the brown algae, which consist of total 240 species, are found in fresh water, whereas other genera, excluding the species

Sargassum, which is populated in brackish lagoons are found in the sea (Turna, 1997). That the population of three species belonging to *Sargassum* (*S. horunschuchii* C. Agardh, *S. vulgare* C. Agardh, *S. acinarium* (L.) C. Agardh) in Antalya Bay and its vicinity (study area) exists, but that the taxa could not be detected during the study was probably due to the fact that these species are stenohalin and stenotherm. The salinity rates in the study area were recorded at 13.3-29.5‰, and the water temperature was approximately 13.3-29.0°C (see Table 1).

The macrobenthic algae which exist in Beymelek Lagoon could not be found at the Stations I, II, III, and IV. Benthic materials collected at the cited stations were dark colored and muddy-pebbly. This is because of the fact that macrobenthic algae usually grow on the rocks-stones and hard substrata (Fritsch, 1945). Benthic materials collected at the Station V were muddy. Moreover, existence of the taxa *G. oxysperma, E. intestinalis, E. prolifera, C. crassa, C. coelothrix* was also revealed in the depth of the study area. Yet, it was determined that these species are not depended upon any substrate. This case could have resulted from the fact that the algae on the coastal parts had been free-floating as a result of their breaking off the hard stratum.

Members of Ulvales order, which we have discovered in study area, are defined as the indicators of the areas that are exclusively rich in organic substances (Dural, 1988; Palmer, 1980). In this study, the taxa belonging to this class (*E. intestinalis*, *E. prolifera*, *E. linza*, *U. rigida*) have been found dispersed at the stations V, VII, and IX. Neither any settlement nor human activity along the shores of Lake Kaynak (Station VII) was determined throughout the sampling period. Besides, trout culture cages have been holding their place of approximately 20 square-meters exclusively on Lake Kaynak. However, the fact that intensive settlement and greenhouses which are all due to human activity located on the northeastern coast of the lagoon has proved to be prevalent in the vicinity of the station IX. Furthermore, it was also found out that the coastal area had been stinking frothy especially in spring season, and that the frothing had been taking place on the surface of water. *E. linza* and *U. rigida* species appear to have formed dense populations in this region. *Ulva* species in Antalya Bay were observed to reach maximum biomass in autumn by reproducing steadily beginning from spring (Turna *et al*., 2002). *U. rigida* is present only in spring and winter seasons in the region and that it forms intensive populations especially at the station IX could arise from the fact that this species distribution is more prevalent, when compared to *Enteromorpha* species, in the areas which contain more organic substances. *G. oxysperma* was proved to be densely populated on the water surface of Lake Kaynak, which has a connection with the lagoon, yet not to exist in benthic area. This epilithic species is known to reproduce depending on the stratum in infralittoral zone. Nevertheless, it has free-floating forms on brackish waters (Delepine *et al*., 1987; Dural, 1988). Brackish water characteristics of the area are the main factor causing the non-existence of the species *G. oxysperma* in the benthic area. *G. oxysperma* has now an increasing importance with regard to human nourishment as it possesses a crude protein content of 16 % in dry matter. For that reason, these algae are produced using synthetic nets in Japan and then marketed under the name of "Aonori" after the drying process (Levring *et al*., 1969). The study also revealed that *G. oxysperma* was densely populated on the 1/3 part of the 6-hectare Lake Kaynak (see Figure 1) so that this species could reach a fresh weight of 418kg (921 lb) in spring, 1106 kg (2438 lb) in summer, 848 kg (1870 lb) in autumn, 100 kg (220 lb) in winter. Moreover, *G. oxysperma* along with the *Enteromorpha* species, which are known to be consumed as food, could provide an economic input for the region.

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